2009

WIND ENERGY RESOURCE GUIDE: COMMON QUESTIONS AND CONCERNS

Devon Bank in Wheeling (LEED Gold and going Platinum)

WIND ENERGY TASK FORCE

OF LAKE COUNTY

COMMUNITIES

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THE WIND ENERGY TASK FORCE OF LAKE COUNTY COMMUNITIES

The Wind Energy Task Force (WETF) of Lake County Communities consists of officials, managers and staff from the County, municipalities, and local private planning and engineering firms, who are committed to promoting responsible wind energy policies. The WETF is a collaborative effort drawing upon the collective resources of the participating Communities to develop comprehensive educational and regulatory materials to be shared to anyone interested in the Wind Energy topic. This handout is intended to be a supplemental document to the Model Ordinance for Wind Energy Systems that was developed by the WETF for the County and municipalities to use as a template or starting point when proposing to create their own Wind Energy regulations.

This document is intended for informational purposes only, and is not intended to be entirely comprehensive. It mainly addresses common concerns and questions about Residential Wind Energy System installation and operation (Building Mounted & Small Wind).

SPECIAL THANKS TO THE FOLLOWING TASK FORCE MEMBERS AND THEIR RESPECTIVE COMMUNITIES FOR THEIR TIME AND EFFORT DEDICATED TO THIS DOCUMENT:

DAVID HUSEMOLLER	LAKE COUNTY
MARIA LASDAY	VILLAGE OF BANNOCKBURN
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Village of Libertyville
City of Lake Forest
City of Highwood

TYPES OF WIND ENERGY SYSTEMS

Wind Energy Systems are devices that produce electricity from wind. Moving air causes the turbine to rotate, which generates clean, emissions-free energy that can be used to power a home, farm, school, or small business. Wind Energy Systems include a turbine that is technologically advanced but mechanically simple, with only two or three moving parts. The Wind Energy Systems available to consumers include: Building Mounted, Small, and Large Wind Energy Systems[1]. These systems will generally be one of two types: Horizontal Axis Wind Turbine and Vertical Axis Wind Turbine.

Building Mounted Wind Energy System (BWES)

Specifically refers to Wind Energy Systems that are structurally attached either onto the roof of or to the side of a building. A BWES typically has less than 1 kilowatt (kW) in nameplate capacity. Some sources include BWES in the same classification with Small Wind Energy Systems. The WETF created this as a separate category due to its different regulatory considerations. Since they require less space, BWES may be more appropriate for more developed residential areas. The adjacent picture is an example of two (2) BWES turbines attached to a single-family home.

Some examples of current BWES applications in Illinois:

- Hyacinth Place, Highland Park [Contains GALE T1 Vertical Access Wind Turbine, 1.02 kW]
- Magee, Negele and Associates, Round Lake [Hybrid Aeroturbines, 1 kW each]

Small Wind Energy System (SWES)

Include any tower-mounted turbine up to 175 feet in height to the top of the blade, typically producing between 1 kW to 100 kW of energy. A SWES is generally used to produce power primarily on-site for a single-user. They are ideally suited for individual homes, small businesses, farms, and similar small-scale establishments.

Some examples of current SWES applications in Illinois:

- Prairie Crossing Farm, Grayslake [Apx. 100 feet tall, 20 kW]
- Devon Bank, Wheeling [Windspire turbines (apx. 30' tall), 1.2 kW each]
- Chipotle, Gurnee [Proven WT6000 turbine (58' tall), 6 kW]

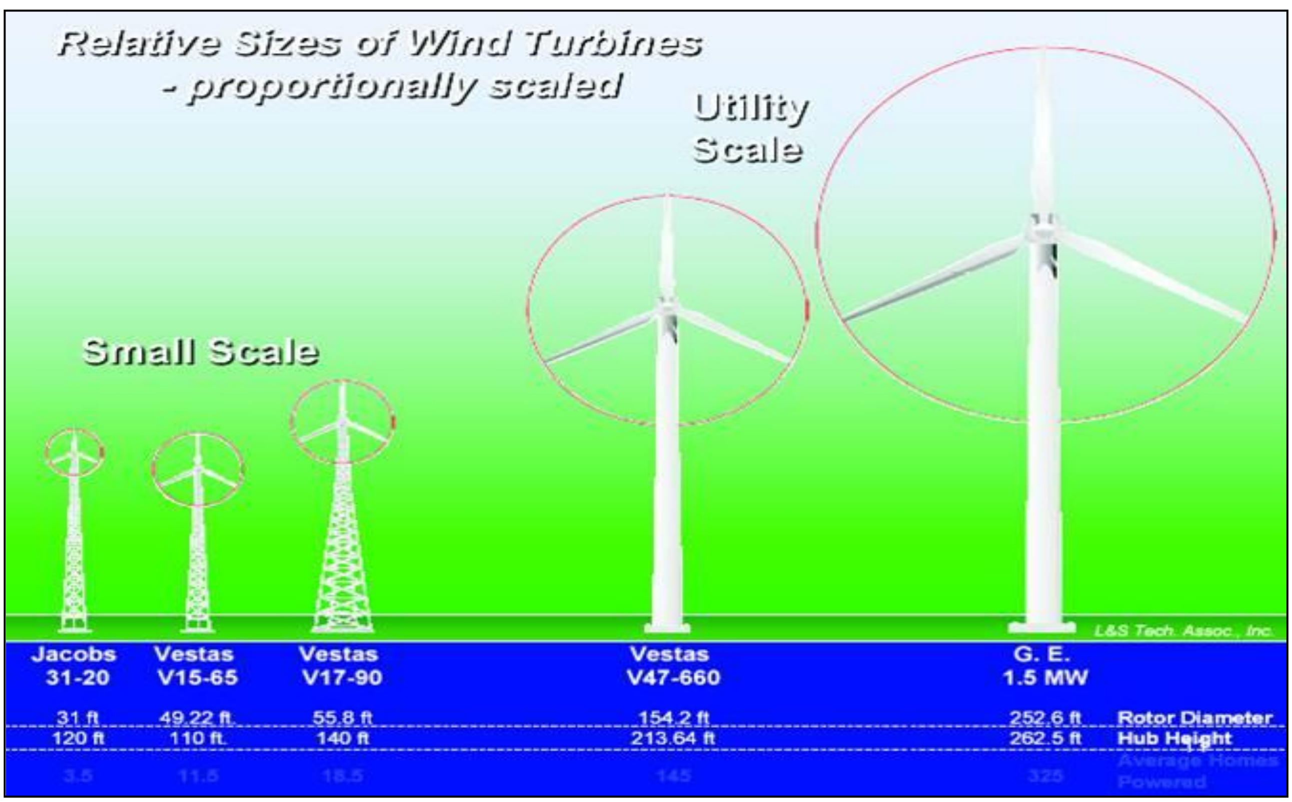
Prairie Crossing Farm

Large Wind Energy System (LWES)

Typically include turbines with a capacity ranging from 100 kilowatts (kW) to 2.5 megawatts (MW) in the largest models that are currently available. The overall height of a LWES can range from 175 to 450 feet and are sometimes referenced as “utility scale”, as illustrated in the figure below. The LWES is a typically a commercial wind project, since it is capable of producing enough electricity for commercial sale. LWES projects can be a large wind farm with as many as 700 turbines. A LWES project may also be as small as a single turbine large enough to power a school that sells off the excess electricity. Please note that this report is designed for smaller residential turbines (BWES & SWES). While the LWES have similar concerns and questions, they are at a larger scale and intensity than the smaller residential turbines.

Some examples of current LWES “wind farms” in Illinois and around the country include:

- 781 MW total capacity Roscoe Wind Complex in Roscoe, Texas [627 total turbines] (this is currently the largest wind farm in the world & can power 230,000 homes).[2]
- 396 MW total capacity Twin Groves I & II wind farm near Bloomington, Illinois [240 total turbines of 1.65 MW each].
- 200 MW total capacity Meadow Lake I wind farm, White & Benton County (NE Indiana – off of I-65) [124 total turbines of 1.65 MW each - The gear box and slowly rotating, three-bladed rotor are perched atop towers that are 262 feet in height. The three-bladed rotor spans 269 feet in diameter and turns at about 14 revolutions per minute (rpm).] The potential full build out capacity is estimated at 1,000 MW which would be 606 total turbines at 1.65 MW each.



The Horizontal Axis Wind Turbine

The Horizontal Axis Wind Turbine (HAWT) is the more conventional model. The rotor shaft and generator are located at the top of the tower, and the blades are angled into the wind. Smaller HAWT's often include a wind vane (or tail) to help direct the blades into the wind. Most HAWT's have a gearbox, which adjusts the rotational speed of the blade to help drive the generator, both when the wind is too light and too strong.

HAWT blades are always perpendicular to the wind. As a result, they maintain much higher efficiency levels than other wind turbine models.

Since HAWT blades, gearboxes, and generators can become fairly heavy, taller and more visible towers need to be built to support the weight, which can cause installation costs to become increasingly more expensive as the height of the tower increases. While HAWT's can be installed on rooftops, they tend to be much smaller and maintain a capacity of only a few kilowatts.

6 kW Proven WT6000 turbine at Chipotle, Gurnee, IL

The Vertical Axis Wind Turbine

The Vertical Axis Wind Turbine (VAWT) is ideally suited for urban and suburban settings. In this model, the rotor shaft is arranged vertically, which means that a VAWT does not need to be pointed into the wind to produce energy. They can be installed on rooftops of buildings and private homes as well as on towers (which also tend to be smaller than HAWT's on average). VAWTs come in two forms: *lift*- and *drag*- based designs. Some examples of the VAWT include, the cup anemometer, stacked savonis rotor, Darrieus Lift-Type Vertical Axis Machines, among others[3]. *The image to the right is of a Vertical Axis Wind Turbine at Magee, Negele and Associates, Round Lake [Hybrid Aeroturbines, 1 kW each].*

Since VAWT's can take advantage of any wind direction, they do not require pitched blades or yaws to capture wind energy. No efficiency is lost due to a change in wind direction, however, overall a VAWT tends to be less efficient than HAWT's, due to the increased drag of the blades. For more information regarding the variety of VAWT's available, refer to the American Wind Energy Association's webpage: http://www.awea.org/faq/vawt.html.

Type of Wind Energy System Support Towers

There are a number of towers available for supporting a wind turbine, with the monopole, lattice tower or guyed tower being the most common free standing structures. The monopole tower generally has a "tidier" appearance than a lattice tower (like a radio tower) or guyed tower (like a flag pole with wire supports), but they can cost several thousands of dollars more and should not be considered equal economic substitutes. All towers on the market are professionally engineered for safety and reliability, leaving appearance and cost the only significant differences among them.

Monopole Towers

Monopole Towers are the most common design, using a tapered cylindrical structure and look like a flag pole. Climbing pegs are often included to allow for regular maintenance. . Installation costs increase significantly with height, but the footprint is the smallest/least of any of the tower types and has a “tidier” appearance when compared to a lattice or guyed tower. Generally this is the most expensive of the towers. (The picture to the left is a turbine located in Cleveland, OH)

Tilt-Up Towers

Tilt-Up Towers are the most expensive models for wind turbines. A gin pole is fastened to the base of the tower, and the entire structure is then pulled into an upright position by a winch. This makes installation and maintenance much easier processes. They can also be lowered during hurricane-force winds to prevent damage. Tilt-up towers do require ample horizontal clearance when being installed and many models also include guy wires, which further increase the footprint of the tower.

Lattice Towers

Lattice Towers utilize three- or four-legged lattice structures without guy wires and can be compared to the older radio and cellular towers that still might be located in communities. They are less expensive than monopoles and tilt-up towers, and also have a smaller footprint than guyed wire towers. (The picture to the left is a lattice tower turbine located in Downers Grove, IL)

Guyed Wire Towers

Guyed Wire Towers require the most land of any of the design types and are like a flag pole with wire supports. Metal cables are attached to the tower and the ground to provide greater support when the turbine experiences higher wind speeds. Guy-wire can also compliment any of the previous three designs.

Rooftop Turbines (aka BWES)

Rooftop Turbines have become increasingly popular in suburban and urban areas. VAWT and Building Mounted Horizontal Axis Wind Turbines are ideal for this type of turbine, since they do not require the same amount of clearing space as a small wind energy system. (*The picture to the left is the Hyacinth 1.02 kW BWES Turbine on a residential building in Highland Park.)*

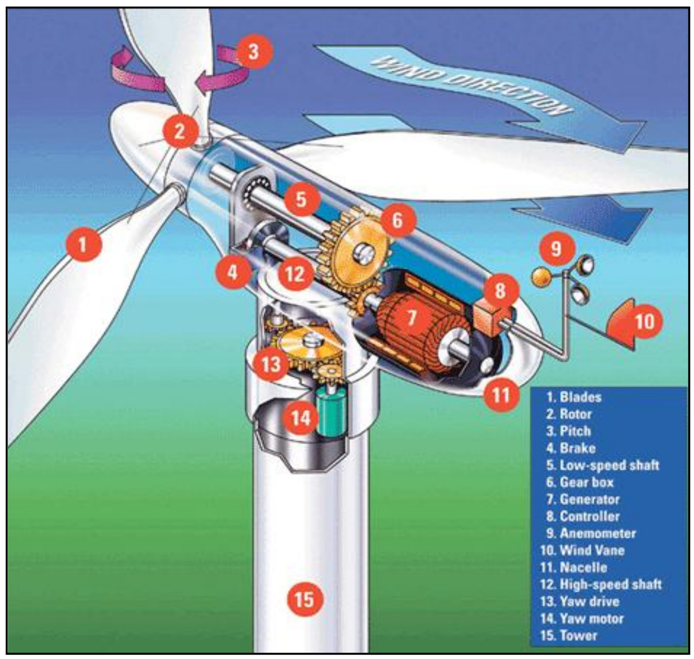
TECHNICAL ASPECTS OF WIND ENERGY SYSTEMS

Why Wind Energy Systems?

In light of the growing concerns about climate change, the rising cost of energy, and other forms of pollution caused by carbon emissions, more Americans than ever are considering wind energy as a clean alternative to other energy sources. According to the United States Department of Energy's National Renewable Energy Laboratory, the majority of Lake County enjoys average wind speeds of 12 to 14.5 miles per hour at 50 meters in height (See Figure A below).[4] The Illinois Institute for Rural Affairs, on the other hand, estimated average wind speeds of 18 to 20 miles per hour in 2007 at the same altitude.[5] These reported wind speeds are adequate wind speeds to generate electricity; however, they may still not be strong enough to fully maximize the energy output of the turbine. Refer to the turbine manufacturer specifications provided with your turbine for details on what wind speed the turbine is rated at (or the maximum capacity). For your reference, Figure C at the end of this document has been provided to illustrate the wind speeds and the potential for wind energy production within the United States.

How do turbines work?

Wind Energy Systems (horizontal & vertical) use the power of the wind to rotate blades and convert the kinetic energy from the wind into electricity, without any carbon emissions. The wind spins the turbine's blades, which creates a rotary motion to drive the generator and produce electrical power. That power can be used on site or transmitted to an electric transmission grid. The picture to the right illustrates the inner components of a typical *Horizontal Small Wind Energy System* (defined below).



The blades of most Small Wind Energy Systems must be propelled by winds of at least 10 miles per hour in order to maintain a high level of efficiency.[6]

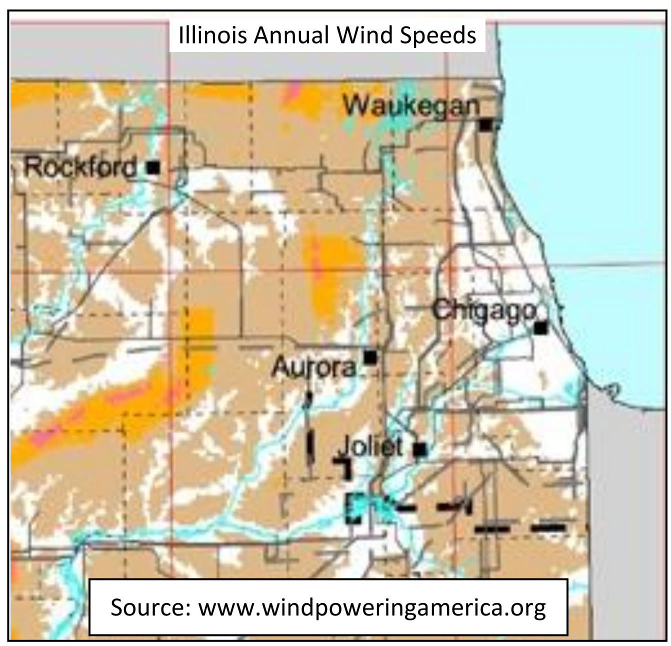
What size Wind Energy System do I need?

The size of the wind turbine you need depends on how much energy you wish/prefer/want/desire to generate, the physical location where the turbine is proposed, and the average wind speeds in your area (the latter two are discussed in the following sections). For residential applications, before you even consider a wind turbine, you should establish an energy budget (http://www.paystolivegreen.com/2008/09/energy-savings-calculator/) to help define the turbine size you will need. Because energy efficiency is usually less expensive than energy production, making your house more energy efficient first will probably be more cost effective and could reduce the size of the wind turbine you need. Additionally, wind turbine manufacturers can help you size your system based on your electricity needs (i.e., they can provide you direction on turbine products that *at maximum efficiency* produces "X" kWh per day), the specifics of local wind patterns and the location of the proposed turbine.

Turbines used in residential applications can range in size from 400 watts to 100 kW (100 kW for very large loads), depending on the amount of electricity you want to generate. A typical home uses approximately 10,000 kilowatt-hours (kWh) of electricity per year (about 830 kWh per month). Depending on the average wind speed in the area (check your local wind speed maps), and the location of the turbine relative to objects that may break up a strong and sustained wind (this is discussed in the following sections), a wind turbine rated in the range of 5 to 15 kW would be required to make a significant contribution to the full demand of a home's electricity usage. A 1.5- kW wind turbine will meet the needs of a home requiring 300 kWh per month in a location with a 14-mile-per-hour (6.26-meters-per-second) annual average wind speed (which is equal to producing 36% of the electricity of a typical home). The manufacturer can provide you with the expected annual energy output of the turbine as a function of annual average wind speed. It must be noted that the "expected annual energy output" is not a definite number and can vary drastically if the winds you utilize are not performing per the manufacturers' standards. This information, along with your local wind speed, your energy budget, and how much capital you are willing to invest in the technology will help you decide which size turbine will best meet your electricity needs.[7]

How Do I Choose the Best Site for My Wind Turbine?

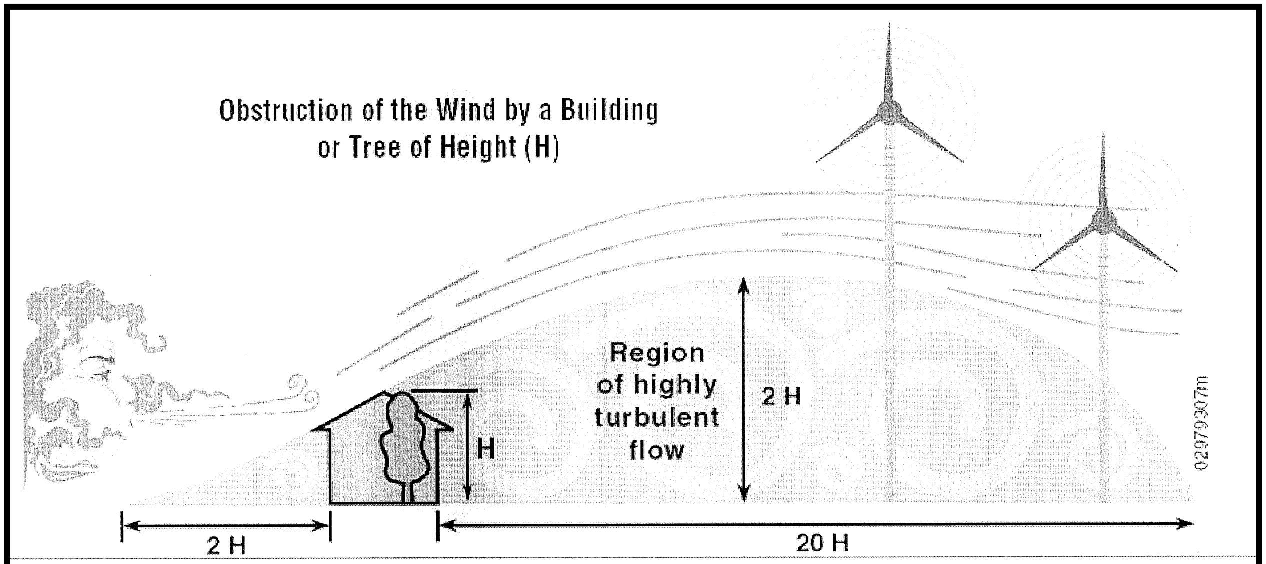
The first step is to find out the annual wind speeds through historical maps (see picture of the annual wind speeds below for northeastern Illinois or refer to Figure A below for the full state of Illinois wind map) or have a study performed on your site for more precise wind speeds. Maps on wind speed can be found by going to the website: *www.http://renewableenergy.illinoisstate.edu/wind/.*



You also need to know about the prevailing wind directions at your site. In addition, you must note whether there are geologic features or other manmade structures in the area that can cause a varied wind speed within the same property. For instance, if you live in complex terrain, take care in selecting the installation site. If you site your wind turbine on the top of or on the windy side of a hill, for example, you will have more access to prevailing winds than in a gully or on the leeward (sheltered) side of a hill on the same property.

In addition to geologic formations, you need to consider existing obstacles such as trees, houses, and sheds, and you need to plan for future obstructions such as new buildings or trees that have not reached their full height.

In order for free standing small wind energy system to have maximum efficiency, your turbine should be sited at least 300 feet upwind and 30 feet above any buildings, trees, or other tall obstacles. The picture below illustrates this concept in more detail.



The farther you place your wind turbine from obstacles such as buildings or trees, the less turbulence you will encounter.

You also need enough room to raise and lower the tower for maintenance, and if your tower is guyed, you must allow room for the guy wires that extend beyond the tower.

Whether the system is off-grid or grid-connected, you will also need to take the length of the wire run between the turbine and the load (house, batteries, water pumps, etc.) into consideration. A substantial amount of electricity can be lost as a result of the wire resistance—the longer the wire run, the more electricity is lost. Using more or larger wire will also increase your installation cost. Your wire run losses are greater when you have direct current (DC) instead of alternating current (AC). So, if you have a long wire run, it is advisable to invert DC to AC. [8]

The Importance of Height & Wind Energy Systems

In order to harness the optimal, higher wind velocities, wind turbines' heights must necessarily be adjusted according to the geography of the property in question and as previously discussed in the section titled *How do I choose the best site for my wind turbine*. When determining power created, wind speed has an exponent of 3 applied to it, which means that even a small increase in wind speed results in a large increase in power.[9] Therefore, a taller tower will generate more wind energy as is illustrated in diagram below for Small Wind Energy Systems from 30 to 150 feet in height.[10]

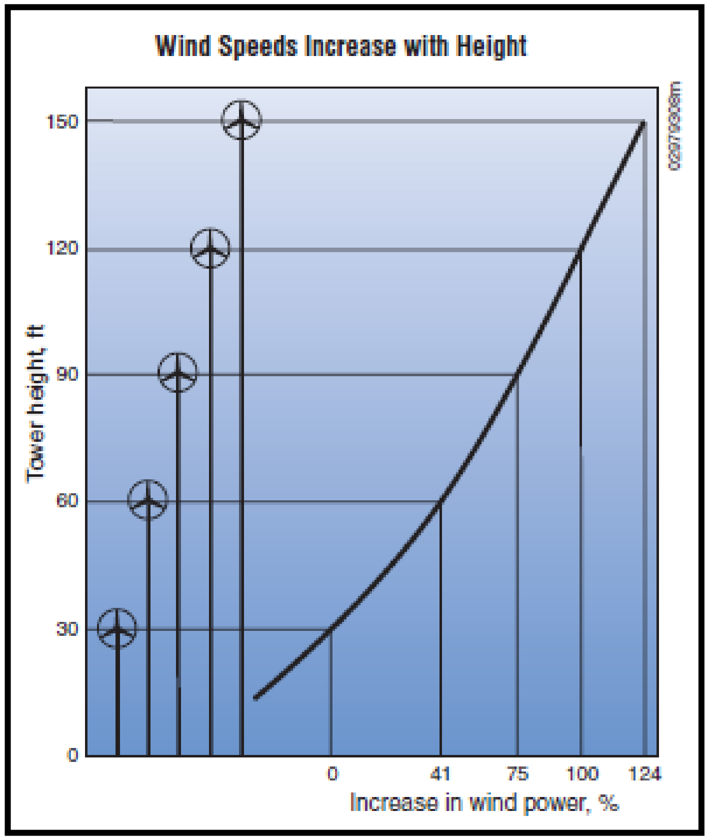
Wind speeds increase with height.[11] Note, the following:

a. From a 30' to a 60' tall tower, there is a 41% increase in wind power.

b. From a 30' to a 90' tall tower, there is a 75% increase in wind power.

c. From a 30' to a 120' tall tower, there is a 100% increase in wind power.

d. From a 30' to a 150' tall tower, there is a 124% increase in wind power.



<u>There is no correlation between generator size (kW produced) and the tower height.</u>

Both factors (tower height & generator size) are independently determined on a case-by-case basis according to surrounding terrain, average wind velocities, and property location.[12] See Figure B at the end of the document titled "Power from the Wind" for an additional figure which re-illustrates the importance of wind speed (and therefore height) when placing a turbine.

COST TO CONSTRUCT WIND ENERGY SYSTEMS

A 2007 market study by the American Wind Energy Association acknowledges "roughly 7,000 Americans purchased small wind systems in 2006...these systems are still far too expensive for most consumers."[13] The Daily Herald estimates that standard Residential Wind Turbines generally range from $23,000 to $35,000 in installation costs.[14] Whereas, per Entegrity Wind Systems, Inc., a larger 50 kW tower at approximately 126 feet tall costs in excess of $200,000 to install. Lastly, with the popularity of turbines they are becoming more available to consumers at prices that are more reasonable. Specifically, Ace Hardware will begin selling a small turbine in their store in 2010, which is currently available on the web for approximately $6,000.[15] Per Ace Hardware's website, this turbine model is the Honeywell Wind Turbine (WT6500) and can generate a maximum of 2500 kWh per year under optimal wind conditions.

According to the American Wind Energy Association, wind turbines can lower electric bills by 50 to 90 percent, depending upon how much energy is used at the residence and how much energy the wind turbine produces.[16] However, in the April 15, 2008 publication of the New York Times, it was reported that it can take up to twenty years for homeowners to regain the installation cost.[17] To put this in perspective, if a homeowner purchased a turbine that cost $25,000 (including installation) and had an average yearly electric bill of $2,000, it would take 12.5 years for the homeowner to "re-coup" the capital costs involved with the purchase and installation of the turbine. The time it takes to recoup the overall cost of the turbine depends on the turbine (power it is capable of producing), the residence (high or low in topography), and the surrounding environment (open fields or large woodlands).

In recent years, many citizens who have installed residential wind turbines have reported that their models have consistently underperformed compared to the manufacturers' claim of ultimate efficiency of the turbine. The Commissioner of the Massachusetts Department of Energy Resources reports that 19 turbines tested averaged about 25% of the manufacturers' estimated energy production.[18] Individual residences will experience differing results depending on the size and geographic location of the home, air conditioning use, lighting usage, and other factors as previously discussed.

Consumers have only recently started to connect individual wind turbines to electricity grids.[19] Any excess energy produced by the wind turbine can be sold back to the utility (get approval from utility company). For example, if a resident installs a 1 kW Small Wind Turbine, all energy produced after the 1 kW capacity has been reached will be sold to the grid. Not every utility, however, will permit grid-connected wind turbines.[20] It will be important that a consumer proposing to install a wind turbine contact Commonwealth Edison Utility (power company) to obtain the proper procedure for connecting to the electricity grid. For contact information, you should utilize Commonwealth Edison's website (www.comed.com).

Tax Incentives

The following incentives are provided for informational purposes only and are not all inclusive. Homeowners may claim a Federal income tax credit of 30% of qualified expenditures for small wind energy systems on a property that serves as a residence by the taxpayer. *The Energy Improvement and Extension Act of 2008* extended the tax credit to until December 31, 2016. The maximum credit is $500 per half kilowatt, not to exceed $4,000, for systems placed in service after 2008.

The State of Illinois provides an additional tax credit of 30% of installation and labor costs for private businesses and residences and 50% of installation and labor costs for public sector and non-profit businesses. Customer must pay for at least 25% of the overall project costs. Please refer to the Database of State Incentives for Renewable Energy (www.dsireusa.org) to stay afoot of the most current available incentives.

COMMONLY DISCUSSED CONCERNS

Aesthetics

While in many cases, wind systems can evoke images of Illinois' rural history, for neighbors of properties that maintain wind turbines, the primary concern has consistently been the visual impact of these devices. Capturing the strongest prevailing winds may necessitate that wind turbines are situated in more sensitive locations, which may affect sight lines from neighboring properties. This problem becomes particularly acute in areas where there are few surrounding features for the wind turbine to blend into.

While the previously mentioned tower heights may seem exaggerated, in a September, 2008, report published by the American Wind Association stated "[p]utting a turbine on too short of a tower is like placing a solar panel in the shade."[21] Wind turbines operate most efficiently when there are few or no obstructions to prevent them from harnessing the faster and stronger prevailing winds that exist above tree lines and buildings. If people try to 'conceal' wind turbines from neighbors' views, they inevitably compromise the efficacy of the wind turbines.

Complaints have arisen in the past about the lighting on wind farms and individual turbines. While currently an unresolved issue for most residential and small-business purposes, the Federal Aviation Administration mandates lighting for structures more than 200 feet in height for aviation safety. Ordinances such as the WETF Model Ordinance limit lighting from WES facilities unless they are required by the FAA or other agencies.

Potential for Structural or Electrical Failure

Instances of electrical or structural failures have become increasingly rare in the past decade as renewable energy machinery is more reliable and subject to more safety precautions.[22] Wind turbines are regularly equipped with gearboxes that ensure that the blades rotate within a controlled range of speed. They are also designed to automatically shut down during power outages with built-in breaking systems. These breaking systems are the system that limits the blades from rotating at speeds above manufacturer specification.

Turbine's Lifespan

Estimates for a turbine's lifespan range from one to a few decades. However, most studies focus on the installation while the everyday operation of the turbine, and the timetables for the removal and recycling of wind turbines have been largely ignored.[23] If the wind turbine is built high enough to reach the more stable winds above tree lines and buildings, less strain will be placed on the overall structure. This can help reduce long-term maintenance costs and prolong the lifespan of the turbine.[24] Many communities require a decommissioning plan for turbines that become inoperable or abandoned which defines how the turbine will be removed by the property owner.

Shadow Flicker

Shadow Flicker is the on-and-off strobe light effect caused by the shadow of moving blades cast by the sun passing above the turbine. Shadow flicker is a function of several factors, including the location of people relative to the turbine, the wind speed and direction, the diurnal variation of sunlight, the geographic latitude of the location, the local topography, and the presence of any obstructions[25]. The American Wind Energy Association claims that Shadow Flicker is not an issue and can be mitigated by setbacks, since the optical effects of the flicker dissipate with distance.[26] Per the Committee on Environmental Impacts of Wind Energy Projects, National Research Council, "a typical result (shadow flicker) might indicate, that a house 300 meters (984 feet) from a 600 kW wind turbine with a rotor diameter of 40 meters (131 feet) will be exposed to moving shadows for approximately 17-18 hours annually, out of a total of 8,760 hours in a year"[27]. This accounts to a total of approximately 0.2% of the year and does not take into account whether or not the day is cloudy; thereby blocking any light from the sun which creates shadow flicker.

For instance, the Sangamon County (Illinois) Ordinance concerning wind turbines requires the applicant to conduct a study on potential shadow flicker where it would interfere with neighboring residences more than 1 hour per year. This requirement is for wind farms of 40 or more acres in size, and does not apply to 35' to 80' tall facilities.[28] It should be noted that there is no one set requirement for shadow flicker at the current time, therefore, if a community does believe shadow flicker to be an issue, they may create restrictions that regulate this phenomenon.

Sun Glint

Sun Glint is the reflection of sunlight off any surface of the blades, tower, or other component of the wind energy system. Sun Glint off of the surface of the wind turbine, depending on the height of the tower, can be seen from miles away.[29] While some materials do reflect sunlight more harshly than others, manufacturers can provide non-reflective paint, such as matte finish paint, that minimizes this effect.

Icing

Wind turbines tend not to accumulate ice while they are moving. Turbines are designed to slow down to a stop when ice does build up on the blades. Melting ice will fall downward from stopped or slowly moving blades. Some blades are designed to flex in the wind in such a way as to resist ice accumulation, while others are heated to keep ice from forming.

A study in Switzerland[30] demonstrated that ice can be thrown from moving blades of a Large Wind Energy System. Distance of falling ice depended on the wind speed and rotational velocity. The Swiss study identified 40% of ice fragments falling within the distance of a blade's length and 95% of ice fragments falling within two blades' length. The largest ice fragments noted by the study were a length of 39 inches and a weight of up to 4 pounds. The maximum range of ice thrown from the rotating blades was roughly the system height of the turbine.

While conditions in the Swiss Alps are considerably different than here in Lake County and the chance of being hit by ice throw from a turbine remains small, this and other studies suggest that personal property and safety would be protected if automobile and pedestrian traffic were restricted during periods of winter weather within a distance of the system height of the Large Wind Energy System.

Research has not identified a risk of ice throw from smaller sized horizontal or vertical axis turbines. As is recommended with street lights, trees, and buildings, caution should also be exercised when parking or walking near or under Small Wind Energy Systems during icing or melting weather conditions.

Sound, Frequency, and Vibration

Depending on size and location, wind turbines have been reported to produce less than 40 (dB) decibels, equivalent to the noise produced by a refrigerator or a standard office environment. [31] Decibels measure the intensity of sound emitted from a given object.

The United States Department of Energy states that noise problems have been greatly reduced in recent years through stricter zoning policies and technological developments.[32] Since sound decreases in intensity with distance, noise pollution can be decreased by appropriate setback policies instituted by local governments. Appropriate setbacks help to ensure that whatever noise is generated can be largely confined to the properties on which the turbines are situated. Different setback requirements can exist depending on tower height and the location of the turbine on the property. All noise-emitting devices must comply with Illinois Pollution Control Board regulations for noise.[33]

In a probable attempt to meet lower noise standards, manufacturers have decreased the blades' rotational speeds, improved insulation, and eliminated many of the moving parts (including gearboxes) to create small wind turbines for residential use that operate at "near-ambient" levels.[34] The British Wind Energy Association reported in February, 2005, that turbine noise frequencies and vibrations have no "direct health effects," and are emitted at very low levels.[35] The figure below illustrates the decibel levels of a number of common noises that we hear everyday.

Noise Charts of Common Noises and their respective decibels

NetWell Noise Control

[Source: www.esoundproof.com; Accessed 8-12-2009]

Decibel Level Comparison Chart

Commercial	Industrial	Residential	dB Level
Threshold For Hearing			0
Good Recording Studio		Breathing	10
		Rustling Leaves	15
		Whisper, Mosquito	20
Library		Living / Dining Room	30
Refrigerator Hum		Kitchen / Bathroom	40
Quiet Office	Power Lawn Mower	Home Office	50
		Birds at 10'	55
Conversational Speech			60
Piano Practice		Electric Shaver	60
Business Office		Piano Practice	65
Noisy Restaurant	Inplant Office	Street Traffic	70
Chamber Music		Barking Dog	75
Classroom		Alarm Clock	75
		Television / Dishwasher	75
Airplane at 1 mile	Manual Machines	Vacuum Cleaner	80
Reception / Lobby Area	Handsaw	Garbage Disposal	85
Motor Bus		Telephone Dial Tone	85
Applause in Auditorium		Lawn Mower	85
OSHA Required Hearing Protection in Factory			85
Teleconference Room		Train at 100'	90
Subway	Farm Tractor	Teenage Stereo	90
Sustained Exposure May Cause Hearing Loss			90

Music Practice Room	Electric Drill	Walkman at 5/10	94
French Horn	Average Factory Noise	Blender	100
Orchestra	Diesel Truck	Motorcycle	105
Computer Room	Printing Press	Train	105
Bass Drum	Heavy Truck	Power Saw	110
Dog Kennel	Power Mower	Baby Crying	110
Symphony Orchestra	Punch Press	Squeeky Toy to Ear	110
Pain Begins			120
Disco	Sandblasting	Shot Gun	120
Cymbal Crash	Pneumatic Clipper	Air Raid Siren	130
Dragcar Racing	Military Jet	Shotgun	140
Rock Concert	Aircraft Carrier Deck	Jet Takeoff	140
Chest Wall Begins to Vibrate			150
Ear Drum Breaks Instantly			160
Death of Hearing Tissue			180
Loudest Possible Sound			194

Electrical Signal Interference

Electromagnetic interference can occur due to scattering, reflection, diffraction, or other near-field effects. Satellite TV reception will be compromised if the turbine is directly in the way of the signal as well as any other permanent structure; however cable TV is not affected. Wind turbines can potentially interfere with television reception or other electrical signals per the AWEA.[36]

Lightning Strikes

All wind turbines and guy wires are "grounded", which means that wind turbines – while made of metal – do not build up an electric charge in the tower, but rather disperse it into the ground. However, while a turbine is not "appealing" to lightning strikes, they are still possible which is why turbines incorporate back-up technologies like surge and lightning arrestors and metal oxide varistors which are also used to protect home computers from electrical surges. [37]

Stray Voltage

Stray voltage describes the event when there is voltage between two objects that should normally not have any voltage difference. Large voltages do occur around electrical equipment due to poor insulation systems or some induced voltage from another source.

Birds and Bats

The National Wind Coordinating Committee compared wind turbine bird kill with bird mortality caused by other man-made structures in the United States. It concluded that birds killed by collisions with wind turbines comprise 0.01% to 0.02% of all birds killed by collisions with man-made structures.[38] While this estimate is based on commercial turbines and wind farms, isolated residential wind turbines, which generally are smaller according to local government ordinances currently in place, do not present a significant danger to birds or bats.

A study conducted by the University of Wisconsin-Green Bay concluded that "while bird collisions do occur … the impacts on global populations appear to be relatively minor, especially in comparison with other human-related causes of mortality such as communication towers, collisions with buildings, and vehicle collisions. This is especially true for small facilities."[39] With regard to bats, studies performed at Minnesota's Buffalo Ridge Wind Resource Area concluded that the 2.45 to 3.21 bat fatalities per turbine were not sufficient to severely impact overall bat populations. The data also indicated that the overwhelming proportion of deaths occurred among migrant bats, not resident populations.[40] According to these studies, it appears that birds and bats do not perceive or respond to wind turbines any differently than other man-made structures. While the reports could not distinguish between collisions with the blades or the towers themselves, the distinction may be irrelevant for residential wind turbines.

Property Values of Surrounding Neighbors

While a number of opinions may exist on this subject, to date the Wind Energy Task Force of Lake County Communities has found no published studies noting the potential impact of wind energy systems on the value of adjacent properties. However, due to the ever increasing numbers of wind energy systems, published data will most likely become available in the future.

Abandonment/Decommissioning

Like any other piece of machinery, defunct turbines will inevitably fall into disrepair, and removal will be necessary. When the wind turbine stops operating, the removal cost will be substantial, especially for taller Horizontal Axis Wind Turbines. The WETF of Lake County and the American Wind Energy Association recommends that if small wind turbine owners have inoperable equipment for at least six continuous months, the local government should notify them that they have six more months to make the system fully operable. After that time, the structure should be removed for safety reasons.[41]

REGULATIONS

State of Illinois Statutes

Non home rule of counties in Illinois must comply with state statutes regarding siting and zoning requirements related to wind farms. According to Municipal Code 65 ILCS 5/11-13-26: "A municipality may regulate wind farms and electric-generating wind devices within its zoning jurisdiction and within the 1.5 mile radius surrounding its zoning jurisdiction. There shall be at least one public hearing not more than 30 days prior to a sitting decision by the corporate authorities of a municipality. Notice of the hearing shall be published in a newspaper of general circulation in the municipality. A municipality may allow test wind towers to be sited without formal approval of the corporate authorities of the municipality. Test wind towers must be dismantled within 3 years of installation."[42]

Abandonment and Decommissioning

Some towns require assurance that any non-functioning turbine will be removed after a period of time to prevent unnecessary clutter in a community. Abandonment due to malfunction has become particularly rare due to today's improved technology, though a community should be entitled to recourse should an abandoned turbine present a nuisance[43]. Upon installation, money is deposited for the removal of the turbine.[44] This requirement can vary from community to community.

Certification Requirements

Wind turbine manufacturers must demonstrate that any given wind turbine meets standards for elements including labeling and identification, design, power performance, noise emissions, and structural integrity. Certification does not constitute a warranty, but an assurance of quality by the certification agent. A Type Certification confirms that a specific type of wind turbine (according to size, form, and function) meets standards that are specific to that type.[45]

The WETF of Lake County Communities recommends that each WES shall conform to applicable industry standards, including those of the American National Standards Institute (ANSI). Applicants shall submit certificates of design compliance that equipment manufacturers have obtained from Underwriters Laboratories (UL), National Renewable Energy Laboratories (NREL), Det Norske Veritas (DNV), Germanischer Lloyd Wind Energie (GL), or an equivalent third party.

Delays for certification of future wind turbines will be inevitable. National standards for certification of small wind turbines have only been established in the past few months, and the process of certification takes several months to complete for individual installations.[46]

ADDITIONAL USEFUL FIGURES

Figure A -ILLINOIS WIND RESOURCE MAP

Source: www.windpoweringamerica.org

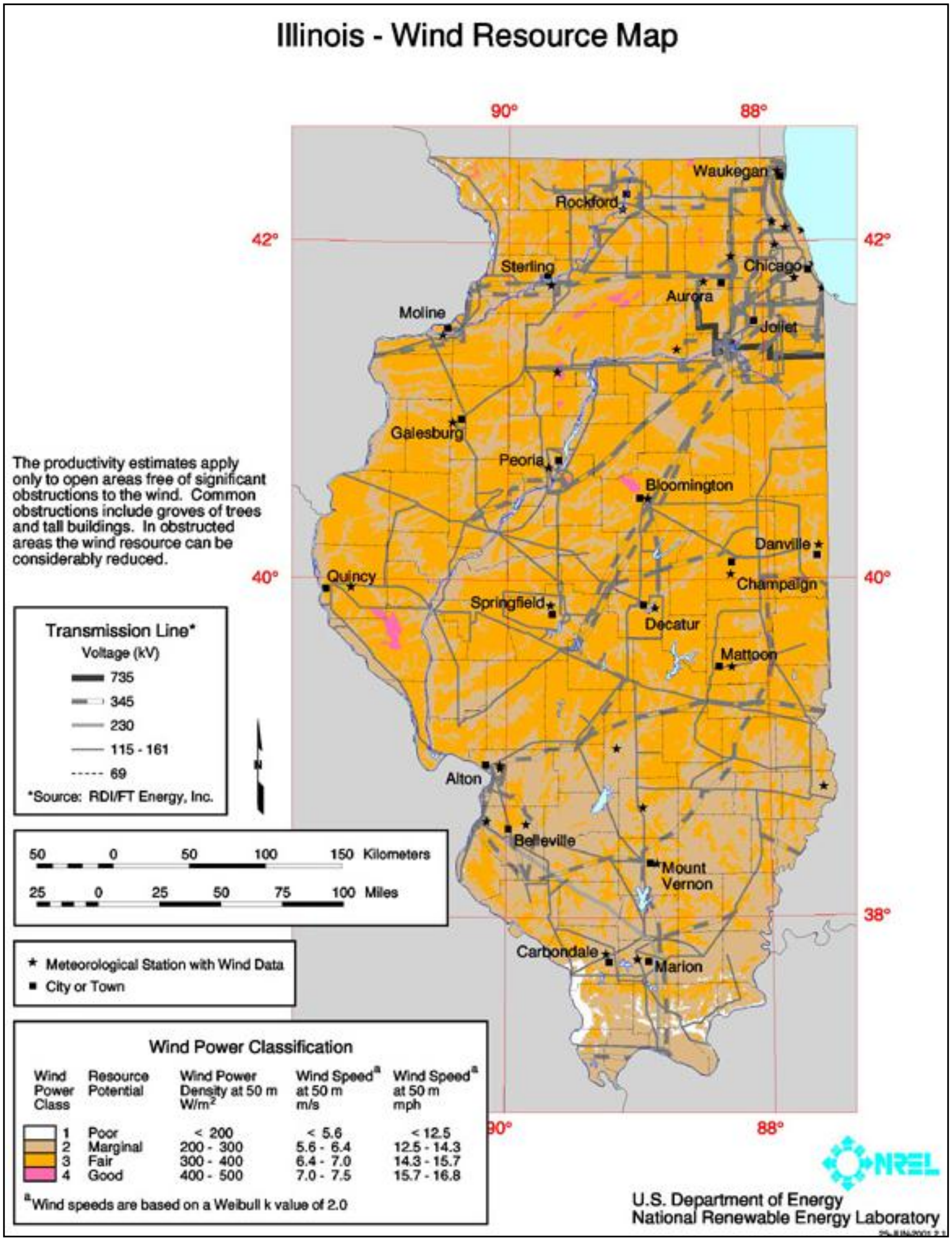


Figure B – INCREASE IN POWER FROM THE WIND

Source: American Wind Energy Association (AWEA)

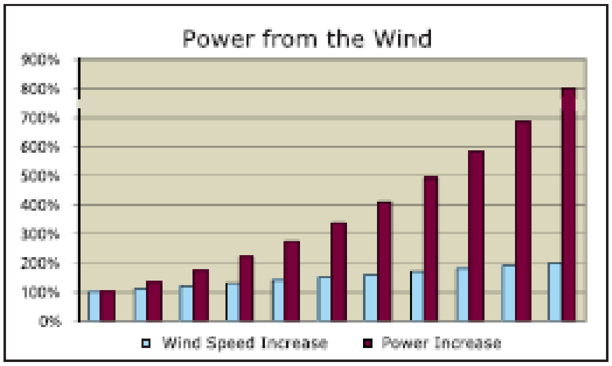
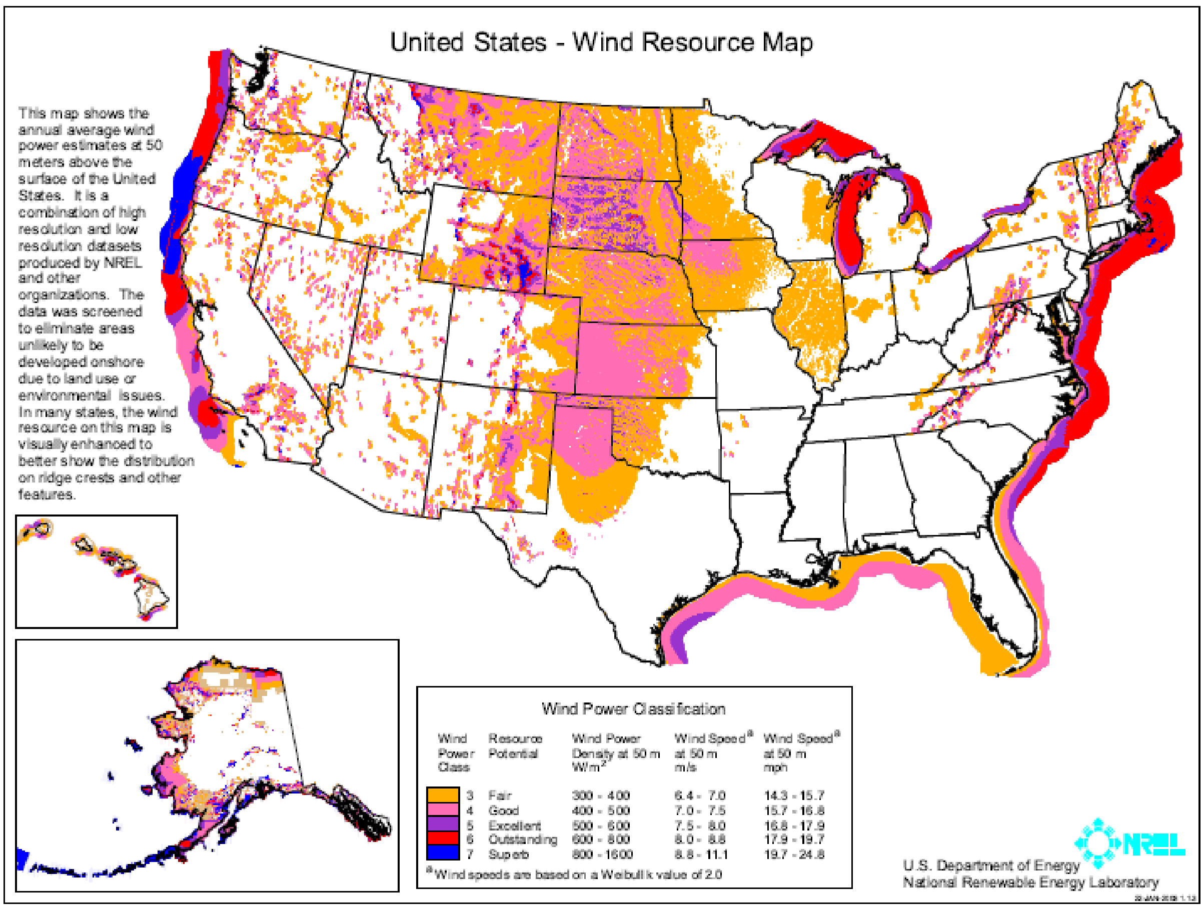


Figure C – UNITED STATES WIND POWER CLASSIFICATION MAP

Source: US Dept. of Energy National Renewable Energy Laboratory



HELPFUL WEBSITE LINKS

A majority of the links below are courtesy of the Illinois Wind Working Group (http://renewableenergy.illlinoisstate.edu/wind/links)

- Wind News Stories (http://windforillinois.blogspot.com/) - a useful link to archived news stories from across the state of Illinois.
- Community Wind Info (www.windustry.org/community/default.htm) - Community Wind Resources and Links from Windustry.org
- Wind Guide for Illinois (www.windustry.org/illinois/default.htm) - Information and resources specifically related to wind energy developments in Illinois and opportunities for Illinois farmers and communities to get involved with this emerging market.
- Illinoiswind.org (www.illinoiswind.org) - Illinois Wind is a website dedicated to information for Illinois residents interested in wind as a source of renewable energy.
- Small Wind in Illinois (www.awea.org/smallwind/illinois.html) - This page provides information specific to public policies, incentive programs, wind resources, and organizational resources for installing and operating a small wind turbine in Illinois.
- Small Wind Electric Systems: An Illinois Consumer's Guide (www.windpoweringamerica.gov/filter_detail.asp?itemid=310) - The purpose of this guide is to provide you with the basic information about small wind electric systems to help you decide if wind energy will work for you.
- Wind Resource Maps (www.windpoweringamerica.gov/wind_maps.asp) - One of Wind Powering America's key activities is to provide validated, high-resolution state wind maps.
- Opportunities in Illinois (www.illinoiswind.org/resources/small/faq05.asp) - This site includes incentive programs for renewable energy, including state policies, utility initiatives, state tax incentives, and other financial incentives and funding programs.
- Gob Nob Wind Turbine (http://66.116.12.173:8085/) - this turbine can now be viewed online through a webcam located at the nearby Farmersville Substation.
- Wind Monitoring Program (www.illinoiswind.org/program/index.asp) - It is essential to measure wind velocity for at least one year in order to forecast how much electricity might be generated at a particular site. Western Illinois University and its Illinois Institute for Rural Affairs and Department of Geography are offering organizations and landowners throughout the state the opportunity to assess the wind at a site under consideration for wind power.
- How Wind Turbines Work (www1.eere.energy.gov/windandhydro/wind_how.html) - Learn more about wind energy technology, including topics such as how turbines work, types of wind turbines, sizes of wind turbines, and a look inside the wind turbine.
- Wind Energy Applications Guide (www.awea.org/pubs/documents/appguideformatWeb.pdf) - This guide provided by the AWEA is designed to briefly explain the applications for which wind power is currently best suited in international applications and provide some contact numbers for further research.

- Small Wind for Homeowners, Ranchers, and Small Businesses (www.eere.energy.gov/windandhydro/windpoweringamerica/small_wind.asp) - The National Renewable Energy Laboratory produced Small Wind Electric Systems Consumer's Guides to help homeowners, ranchers, and small businesses decide if wind energy will work for them.
- Financial Incentives (www.windpoweringamerica.gov/ne_policy_federalgrants.asp) - This is a link to some financial incentives, other than the most well known Production Tax Credit, for eligible renewable resources.
- Small Wind - AWEA (www.awea.org/smallwind/) - This page on the AWEA website shares a wide variety of information on small wind, including details for installing and promoting small wind.
- Small Wind - US DOE (www1.eere.energy.gov/windandhydro/small_wind_system_faqs.html) - This page includes many Frequently Asked Questions regarding small wind, from the U.S. Department of Energy.
- Small Wind - Appalachian State University (www.wind.appstate.edu/swiwind/smallwindrdsite.php) - This webpage features small wind research and demonstration.
- Large Wind/Wind Farms (www.eere.energy.gov/windandhydro/windpoweringamerica/large_wind.asp) - This site includes publications such as Wind Project Development Process, 10 Steps in Building a Wind Farm, and Permitting of Wind Energy Facilities: A Handbook
- Wind Farmers Network (www.windfarmersnetwork.org/) - The Wind Farmers Network is a discussion forum for those interested in wind power to exchange ideas and information about wind power resources, economics, technology, and how to develop a wind project.
- Wind energy policy, transmission & regulation (www.awea.org/policy/) - Resources on wind and other renewable energy sources for regulators and policymakers.
- Farm Bill (www.eere.energy.gov/windandhydro/windpoweringamerica/ag_farm_bill.asp) - The "Farm Security and Rural Investment Act of 2002," better known as the 2002 Farm Bill, includes a number of provisions for renewable energy, especially in the Energy Title of the bill. Several items directly fund or benefit wind energy systems. At this site you can find programs that are funded or enabled by the bill.
- Illinois Incentives for Renewables and Efficiency (www.dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=IL&RE=1&EE=1) - DSIRE is a comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.
- Fat Spaniel Technologies (www.fatspaniel.com/) - Fat Spaniel is the leading provider of critical information services for the renewable energy industry. It provides hosted data monitoring, management and control services that OEMs, installers, and distributed utilities can use to optimize performance and ensure investment returns for all types of renewable energy systems.
- Al E Educational Videos on Wind Energy (www.altestore.com/store/Books-Classes-Educational-Videos/Educational-Videos/c1138/) - This website features free online videos about Renewable Energy Basics.

Info on Wind Energy

- www.awea.org - The American Wind Energy Association (AWEA) promotes wind energy as a clean source of electricity for consumers around the world.
- www.dsireusa.org - The Database of State Incentives for Renewables and Efficiency (DSIRE) is a comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.
- www.nationalwind.org - A U.S. consensus-based collaborative formed in 1994, the National Wind Coordinating Collaborative (NWCC) identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of environmentally, economically, and politically sustainable commercial markets for wind power.
- www.nrel.gov - The National Renewable Energy Laboratory (NREL) is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by Midwest Research Institute.
- www.eere.energy.gov - Energy Efficiency and Renewable Energy, U.S. Department of Energy
- www.windustry.org - Windustry works to increase wind energy opportunities for rural landowners and communities. Windustry promotes wind energy through outreach, educational materials, and technical assistance to rural landowners, local communities and utilities, and state, regional, and nonprofit collaborations.
- http://www.eere.energy.gov/windandhydro/windpoweringamerica/ - Wind Powering America is a commitment to dramatically increase the use of wind energy in the United States. This initiative will establish new sources of income for American farmers, Native Americans, and other rural landowners, and meet the growing demand for clean sources of electricity.

USEFUL DEFINTIONS (From WETF Ordinance – 11-25-09 Version)

Abandonment: Any Wind Energy System (WES) that has not been repaired to operating condition within the reasonable timeframe identified by [the Lake County Community], as provided in this ordinance.

Applicant: The Owner, who is in the process of submitting or has submitted an application to install a Wind Energy System project in [the Lake County Community].

Building-Mounted Wind Energy Systems (BWES): Wind Energy Systems that are structurally attached either onto the roof of or to the side of a building.

Day time: The hours of the day from 7:00 am to 10:00 pm.

Decommissioning: Once a WES has been deemed inoperable or abandoned its components must be disassembled and removed from the premises, including the foundation. Upon removal, the site shall be restored to its original pre-construction condition.

FAA: The Federal Aviation Administration of the United States Department of Transportation.

FCC: The Federal Communications Commission.

Financial Assurance: A reasonable assurance from a credit worthy party, examples of which include a surety bond, trust instrument, cash escrow, or irrevocable letter of credit.

Grid-Intertie WES System: A system that converts wind energy to electrical energy that is connected to an electric circuit served by an electric utility company.

High Quality Aquatic Resource: Waters of the United States or Isolated Waters of Lake County that are determined to be critical due to their uniqueness, scarcity, function and/or value.

Horizontal Axis Wind Turbine (HAWT): This is the most typical type of turbine used. They have the main rotor shaft and generator at the top of the tower, and must be pointed into the wind. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator.

IDNR: The Illinois State Department of Natural Resources.

Large Wind Energy Systems (LWES): Wind Energy Systems with turbine towers and fully extended blades measuring taller than 175 ft. from the ground. LWES include one or more wind turbines, electronic conversion and distribution systems. They typically produce energy to be sold commercially and have a nameplate capacity of 750 kW to 2.5 MW.

Met Tower: A meteorological tower with an anemometer, used for the measurement of wind speed.

Nacelle: The part containing the shaft, gear box, and generator in a typical horizontal axis turbine.

Nameplate Wattage: The amount of energy produced from a Wind Energy System at maximum or optimum wind speeds within one hour, as indicated by the manufacturer.

Night: The time of the day after 10:00 pm until 7:00 am.

Noise: Sound that adversely affects the psychological or physiological well-being of people.

Nonparticipating Property: A property that is not owned by the Owner of the property on which the WES is proposed or installed.

Operational condition: WES facilities being capable of operating at full capacity while meeting all noise, shadow flicker and other permit conditions.

Operator: The entity responsible for the day-to-day operation and maintenance of the WES, including any third party subcontractors.

Owner:

- The person(s), who hold(s) title of the property on which a BWES or SWES facility is installed.
- The entity or entities with an equity interest in the LWES facilities, including their respective successors and assigns.

Participating Property: A property that is owned by the Owner of the property on which the WES is proposed or installed.

Professional Engineer: A qualified individual who is licensed as a professional engineer in the State of Illinois.

Shadow Flicker: The on-and-off strobe light effect caused by the shadow of moving blades cast by the sun passing above the turbine. Shadow flicker intensity is defined as the difference or variation in brightness at a given location in the presence and absence of a shadow.

Silhouette: The area covered by moving blades of WES turbine, as viewed from the front elevation, described in square feet.

Small Wind Energy Systems (SWES): Free-standing, tower-mounted Wind Energy Systems with a system height measuring less than 175 ft. from the ground. SWES facilities are accessory structures that generate power for local distribution and consumption. Generators typically range from 1 kW to 100 kW in nameplate wattage.

Sound: Acoustic waves carried on oscillating particles in the air, generally classified as being one of three types: broadband, tonal, and low-frequency.

> **Broadband:** Sound that has frequencies above 100 Hz. With WES, the aerodynamics from the displacement of air from the turning blades of a wind turbine creates a "swishing" or "whooshing" sensation.
>
> **Tonal:** Noise that is more clearly audible to humans. With WES, this may include mechanical sounds from rotating machinery experienced as "hum" or "pitch" occurring at distinct frequencies.
>
> **Low-frequency:** Sound with frequencies below 100 Hz, including "infrasound," which is inaudible or barely audible sound at frequencies below 20 Hz and may be potentially experienced as vibration. With older downwind turbines, some infrasound also is emitted each time a rotor blade interacts with the disturbed wind behind the tower, but it is believed that the energy at these low frequencies is insufficient to pose a health hazard (BWEA 2005).

Sound Frequency: The frequency of sound (Hz) is defined by the number of oscillations per second and how we perceive noise is partly dependant on what the frequency is. High frequency noise has more oscillations per second, whereas low frequency noise has fewer. Audible sound is usually defined as between 20-20,000 Hz. Infrasound is carried at a frequency so low that it is not audible, but may be felt.

Sound Level Meters: Measure sound in FAST or SLOW settings. In the FAST position, the meter reacts quickly to changes in the sound level, indicating the peak sound levels present in the environment. In the SLOW position, the meter is damped and indicates an average-value sound level. The effect of brief sound peaks is minimized in the SLOW position.

Sound Pressure: Whereas sound *power* is used to describe the source of sound and sound *pressure* used to describe the effect on a receptor, i.e. what we perceive as noise.

Sound Volume: The intensity of sound is measured in decibels (dB(A)). As a reference, a whisper may measure at twenty (20) dB(A), a refrigerator may hum at forty (40) dB(A), a typical conversation may measure at a volume of sixty (60) dB(A), and a vacuum cleaner may register at 80 dB(A).

Structural Engineer: An Engineer who is licensed and registered to practice structural engineering in the State of Illinois under the Illinois Structural Engineering Act and whose principal professional practice is in the field of structural engineering.

Structural Weight: The combined weight of the tower, wind turbine generator, and any other component(s) otherwise supported by the base foundation.

Substation: The apparatus that connects the electrical collection system of the WES facilities and increases the voltage for connection with the utility's transmission lines.

Sun Glint: The reflection of sunlight off of a surface of the blades, tower, or other component of the wind energy system.

System Height: The distance from the ground to the highest point of the WES, including the highest reach of the blades. See local zoning code to see how measurement from the ground is determined.

Vertical Axis Wind Turbine (VAWT): A small scale wind turbine, in which the main rotor shaft is arranged vertically creating an "egg beater" appearance. The generator and gearbox are located near the ground so the tower does not have to support it and it is more accessible for maintenance.

Watt: (Symbol: W) A derived unit of power in the International System of Units (SI). It measures rate of energy conversion. One watt is equivalent to 1 joule (J) of energy per second. The kilowatt (symbol: kW) is equal to one thousand watts. The megawatt (symbol: MW) is equal to one million watts.

Wind Energy System (WES): A wind energy production, conversion and distribution system consisting of a wind turbine, tower, and associated electronics equipment. In other publications this is known as Wind Energy Conversion System (WECS).

Wind Farm: More than one Large Wind Energy Systems (LWES) on a given site, constructed for the commercial generation of electrical power.

Tower: The structure on which the wind system is mounted.

Turbine: The parts of a WES including the blades, nacelle and tail.

FOOTNOTES

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